Optimized Collision Warning Protocol In VANET

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Optimized Collision Warning Protocol In VANET

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by

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Certificate

This is to certify that the work in the thesis entitled " ***Optimized Collision Warning Protocol in VANET*** " submitted by ***Jogendra Majhi*** is a record of an original research work carried out by him under our supervision and guidance in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Engineering, National Institute of Technology, Rourkela. Neither this thesis nor any part of it has been submitted for any degree or academic award elsewhere.

Place: NIT,Rourkela-769008
Date: 24 - 06 - 2015

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I would conclude with my deepest sense of respect and gratitude to my parents and all my loved ones. It would not have been possible to put my full dedication to the work without their blessings and moral support.

Jogendra Majhi

Declaration

I certify that i have complied with all the benchmark and criteria set by NIT Rourkela Ethical code of conduct. The work done in this project is carried out by me under the supervision of my mentor. This project has not been submitted to any other institute other than NIT Rourkela. I have given due credit and references for any figure, data, table which was being used to carry out this project.

Jogendra Majhi
Place: NIT,Rourkela-769008 Date: 24 - 06 - 2015

Abstract

Transportation has become an essential part in our life. As an outcome, number of vehicles are going up day by day. Trafc casualties is getting higher and higher day by day and streets are being blocked and overcrowded. Vehicle accidents have been taking many lives every year, it has now outnumbered the number of death a disaster or a savage infection takes lives in a year. Studies demonstrate that if the driver of the vehicle is given a warning message in less than half seconds before an accident then around 50% roadway crashes could be evaded.

In this thesis a vehicle-to-vehicle communication protocol for collision warning has been proposed. Wireless technology such as DSRC promises to significantly diminish the number of deadly road accidents for vehicle-to-vehicle (V2V) and vehicle-to-roadside (V2R) communication by giving timely warnings. Accomplishing low delivery delay time in conveying Emergency Warning Message in different road circumstances to neighboring vehicles is one of the foremost technical issue addressed in this thesis. Moreover an algorithm for collision avoidance is also stated in this thesis. An effective protocol was designed covering obstruction control policies and techniques for Emergency Warning Message differentiation by taking into account various application requirements. Results from the simulation shows that the protocol proposed in this thesis accomplishes low delivery delay time in conveying Emergency Warning Message even under unpleasant road situation.

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List of Acronyms

Acronym	Description
EWM	Emergency Warning Message
AV	Abnormal Vehicle
RSU	Road Side Unit
V2V	Vehicle to Vehicle
V2I	Vehicle to Infrastructure
I2I	Infrastructure to Infrastructure

Chapter 1

INTRODUCTION

In cities, Traffic congestion is a major issue .The blockage and vehicle gathering issue is complemented by a steady road accidents. Absence of road traffic safety and rise in the number of high velocity vehicle takes a number of valuable human lives and also poses a genuine risk to our surroundings.

As indicated by National Highway Traffic Safety Administration[9], around 6.3 million people were reported of vehicular collisions, among which 43,000 individuals were killed in 2012. The economy impacts brought about because of these accidents were more than $230 billion and Millions of individuals were bruised. Preparatory safeguards like airbags and seat belts are utilized yet they can't wipe out this issues because of drivers inability to anticipate the condition early. On an expressway or in a turning point a vehicle can't anticipate the current velocity of other vehicles. On the other hand, with the utilization of wireless communication hardware, sensor and computers, velocity could be anticipated and an emergency warning message could be sent at regular intervals. Hence the danger of potential accidents could be restricted.

1.1 VANET

A Vehicular Ad-Hoc Network, or VANET, is similar to Mobile Ad-Hoc network where communication occurs between vehicle and adjacent vehicles, with close-by static units, generally portrayed as a roadside unit (RSU). The primary objective of VANET is to give safety and comfort to travelers, drivers and other road users. To accomplish this transceiver will be attached with every vehicle which will form an Ad- Hoc network. Every vehicle is outfitted with transceiver, which will act like a node in the Ad-Hoc network and which will send, receive and pass others emergency warning messages. Road sign alerts, Collision warning and traffic movement perspective will give the driver to choose the best path to reach the destination.

One of the major challenging task for the metropolitan city planners is controlling traffic particularly at road intersections. The condition deteriorates if there is an accident along one way or a truck containing huge stock has broken down at the narrow convergence point. Long queues, slowly moving queues of vehicle lineup and the condition can be exceptionally devastating for one to utilize certain road. Driving through a city where there are narrow roads and insufficient parking zone amid pick hours is a humiliation for time-savers and the intolerant people. Late studies[4] in the United States of America (USA) demonstrate that traffic blockage expenses are a stunning aggregate sum in: Wasted Fuel of 2.3 billion gallons, Delay of 3.7 billion hours, and an Annual Cost of $63 billion to the US economy alone. VANET can be helpful in facilitating these type of encounters and perceptions on the road for the vehicle drivers, tacking traffic wilderness. VANET applies propelled advanced technologies to surface transportation system and are seen broadly as the answer for the traffic control issues and transportation that the 21st Century societies will confront.

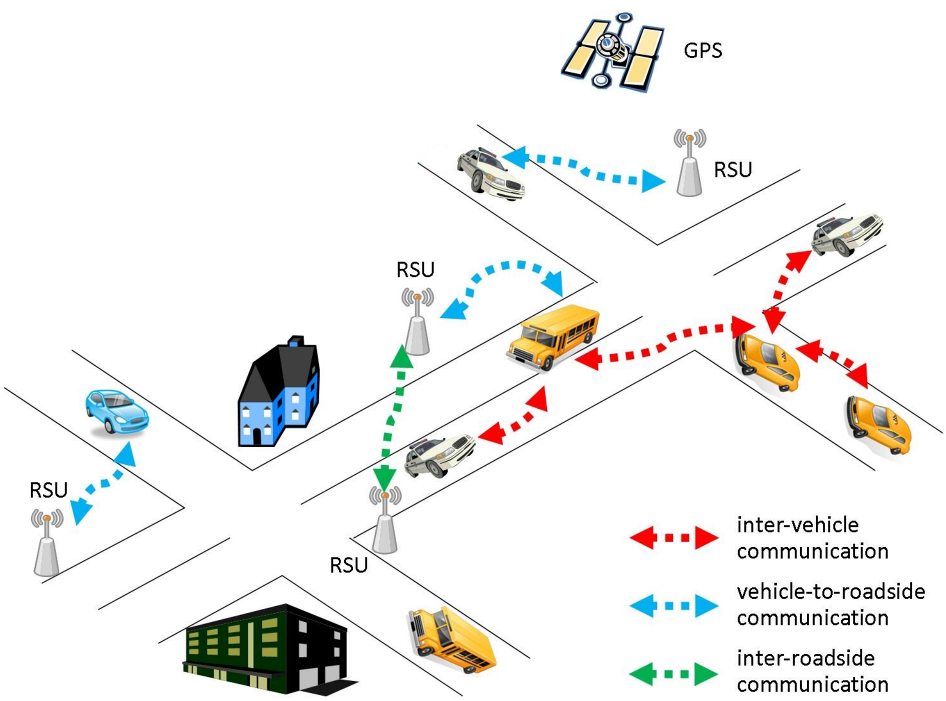

Figure 1.1: Overview of VANET.

As shown in the Figure 1.1 [1], there are three type of communication going on in VANET Vehicle-Vehicle communication, Vehicle-Infrastructure communication and Infrastructure-Infrastructure communication. they have been described in details in the next subsections.

1.1.1 Vehicle to Vehicle Communication (V2V)

It conveys traffic related data by using multi-hop multicast or multi-hop broadcast communication over numerous hops to a group of receivers[6]. VANET for most part is concerned with the road ahead and not about road behind. VANET predominantly utilized two sorts of emergency warning message sending strategies, Nave Broadcasting and Intelligent Broadcasting.

- **Naive Broadcasting :** Emergency warning message is broadcasted periodically at regular interval. In case the emergency warning message originates out from a follower then the vehicle disregards the message and if the message is being generated and passed on from a vehicle in front of it then the vehicle will accept it then it will send its own telecast message to the vehicles behind it. Hence one of the greatest disadvantage of naive broadcasting technique is that huge amount of broadcast emergency warning message are generated and therefore network overhead increases.

- **Intelligent Broadcasting :** In this technique, above limitation is overcomed by utilizing acknowledgements, thus restricting the number of emergency warning message broadcasts. In this case the vehicle in front of the vehicle which is sending the same message from behind it will not accept it because it accepts that another vehicle which is following it has got the message and hence it will be in charge of further transmitting the message. Subsequently it stops the generation of huge amount of broadcast emergency warning message.

1.1.2 Vehicle to Infrastructure Communication (V2I)

Here the Road Side Unit (RSU) broadcasts message to the vehicles in the vicinity. This type of configuration provides ample amount of bandwidth link between communicating parties. Mostly used for traffic optimization messages. DSRC (Dedicated short range communication)is used to transmit the messages to vehicles. Here the RSU plays the role of a coordinator by collecting information from vehicles. It collects data globally or locally on road situation like traffic jam then it guides vehicles what path to choose so that there is less traffic jam on the road[6]. Hence the problem of traffic congestion is solved. In other way round, it can help calculating the relative spreed between the vehicles and moreover limit the speed of an over speeding vehicle in a lane. The police will also get benefited from the RSU, as they can get information regarding the vehicles. They can track the movement of the vehicle, so in this way it can also help in reducing crime.

1.1.3 Infrastructure to Infrastructure Communication (I2I)

As stated above RSU works with DSRC to transmit messages to the vehicles. They gather information from vehicle as well as well from other RSU nearby. Therefore the information regarding any vehicle is tracked and it's very helpful for the police department. A specified area on a map can have RSU located according to some patterns such as one RSU in the center and other RSUs at the circumference of the transmission range circle of the centralized RSU or the RSU may be placed like a grid, where each RSU is situated at a fixed distance from other RSUs[6]. Anyways they gather information from other RSU, so this helps in tracking the vehicle. The RSU work together to guide the vehicles on choosing the less congested road. Hence they work as traffic police.

1.2 Characteristics of VANET

Topology are highly dynamic: VANET have very high dynamic topology .The communication links between node changes very rapidly. Communication between two nodes remains for very less time. For example if the transmission range of the vehicles is about 250 meters and both the vehicles are moving away from each other with a speed of 30m/sec, then the link will only last for 5 seconds. So this shows how highly dynamic the topology can be present in VANET.

Network disconnects frequently: From the above example, we can see that communication between two or more vehicle stays for 5 second or somewhere in the vicinity. To keep up the persistent network vehicles needs another connection nearby quickly. Anyhow, if connection breaks vehicles can connect with Road Side Unit (RSU). Successive detachments in network mostly happens where vehicle density is low like in rural area.

Modelling and Prediction of vehicle mobility: The above two characteristics of VANET highlights that network needs the information of positions of vehicles and their movement however this is exceptionally hard to anticipate since vehicle can move haphazardly and it doesn't have a pattern. So vehicle mobility models forecast which is based on some investigation of predefined roadway model and moreover vehicle velocity are utilized in modeling.

Communication depends on environment: The mobility model differs in diverse environment structure from rural zone to urban territory, from expressway to that of city environment. So mobility modelling and vehicle movement and routing algorithm ought to adjust to these variations. In expressway mobility models are extremely basic on the grounds that vehicle movement is one dimensional. Anyway, if there is an occurrence of city environment where bunches of vehicle are present and distinctive hindrance like building are available it makes communication application extremely complex in VANET.

Very low delivery Delay limitation: Safety feature like emergency warning message in VANET application depends upon the convey time of information. It cannot compromise for information delay in this kind of application. Accordingly very low delivery delay limitation is more vital in VANET than high information rate.

Interaction with on-board sensors: The on-board sensor are available in the vehicle. These sensors are utilized to discover vehicle geographic location, vehicle velocity and vehicle movement these data's are then utilized for successful communication between vehicles.

1.3 Applications of VANET

The main objectives of VANETs will be to enhance safety on the road. To accomplish this, the vehicles act as sensors and pass on the emergency warning messages to distinctive vehicles and this messages incorporate date like velocity of vehicle, condition of road, Traffic density. This empowers the drivers to respond ahead of schedule to any hazardous circumstances like accidents and road jamming. Anyway, the late research in the field of VANET have found numerous applications and technologies to tackle these problems.

Type-1 : Safe Navigation through Application Assistance

- Developing Application for applying sudden braking system to avoid collision by calculating distance between two vehicles.
- Application for detection of hazardous and dangerous driving conditions. This conditions can be damaged road, blocked road, if road is covered with snow or mud.
- Application for emergency call services after an accident occurs here the vehicle can automatically call to authority if an accident occurs.
- Applications for detecting rogue drivers which are disobeying traffic rules like crossing speed limit, talking in phone while driving, driving in the wrong side of the road.

Type-2: Traffic Regulation and Internet Connectivity through Application

- Application for Advanced Navigation Assistance (ANA) such expected weather condition for driving, real time vehicle congestion information, , a car park formation etc.
- For more travel comfort and improved productivity the vehicle can be provided with internet connection services. This be done by data transfer between vehicle and road side unit.
- Chatting services between users of the same root, this can improve driving safety one driver can send immediate warning message to other driver.

1.4 Thesis Organization

The rest of the Thesis is organized as follow:

In **Chapter 2**, a complete survey of the various aspect of Vehicle-to-vehicle communication has been discussed. Various challenges that are present in implementing the proposed algorithm has been discussed in this chapter. Moreover the research work that has been already done and the problem definition that motivated me to work on it has been stated. In the later part of the chapter, the objective of the work done has been stated.

In **Chapter 3**, a collision avoidance model has been presented along with the details of the model discussed briefly. The following assumptions taken and the algorithm proposed to successfully implement the objective has been discussed briefly.

In **Chapter 4**, implementation of the proposed algorithm has been discussed. The simulation environment under which the experiment work was performed along with the results of the experiment that was observed has been discussed briefly.

In **chapter 5**, the conclusion that was obtained from the experiment work has been discussed briefly along with the probable future work that can be done in this field has been stated.

Chapter 2

LITERATURE REVIEW

There has been a lot of work contributed by numerous researchers in distinctive directions. The writing in this field can be exceptionally robust to plan more proficient vehicular Ad-Hoc network system. There is an expansive delay in spreading Emergency warning message because human drivers experience the ill effects of recognition limitations of emergency events occurrence on Highway.

2.1 Survey

Suppose there are three vehicles name it as Vehicle A, Vehicle B and Vehicle C go in the same path,as shown in Figure 2.1 [9], where Vehicle A is being followed by Vehicle B and in the meantime it is being followed by Vehicle C. if vehicle A abruptly applies the brakes suddenly, both vehicles B which is following Vehicle A is in danger, and moreover Vehicle C, being too far from Vehicle A does not even make any more secure than B because of the following two reasons:

Figure 2.1: Scenario of three Vehicle running in the same lane.

- **Inability to see the brake light of Vehicle A :** The driver in Vehicle C will only come to know about the emergency at A until and unless driver in vehicle B puts a brakes because the driver in Vehicle C can only see the brake light from the Vehicle B directly in front of him. If vehicle B is not able to put a brake in time then Vehicle C will not be able stop in time and hence both will collide with vehicle A.

- **Expansive delay time for passing the Emergency Warning Message :** The reaction time, of the driver in Vehicle B from seeing the brake light of Vehicle A and then to stepping on the brakes can take about 0.9 seconds to 1.2 seconds, resulting in expansive delay in forwarding the Emergency warning Message.

In our past case, Vehicle A can send Emergency Warning Messages only when there is an occurrence of emergency event. The drivers of Vehicles B and Vehicle C can be alarmed quickly if they can get the Emergency Warning Messages within very small interval of time. In that event, Vehicle C can keep away from the accident through rapid responses, and Vehicle B will also be profited by that Emergency Warning Message when the driver of Vehicle B is not looking at the environment carefully or when perceptibility is very poor. Therefore,(V2V) communication provides safety to all the drivers of the vehicles (A, B, C) to stop in time and avoid collision.

2.2 Challenges faced by VANET

Challenge 1 : Requirement of very small delivery delay time of EWM soon after the occurrence of emergency event

As soon as possible after an accident occurs, the more quickly the Emergency Warning Message is conveyed to the threatened vehicles, the more and more probable Road accidents could be evaded. We could describe the term Emergency Warning Message (EWM) delivery delay as the time period an Abnormal Vehicle A first time sends its EWM to the first time it is received by vehicle V successfully. The Emergency Warning Message delivery delay should be in milliseconds between the abnormal vehicle and the vehicles surrounding it. Since Vehicles are moving very fast, for an instance a vehicle can cross about one meter in 25 ms, if it's moving at a speed around 75 miles/hour[5]. All the vehicles near to the Abnormal Vehicle may be possibly risked .The Emergency Warning Message should be received by all on time, which would help them in avoiding the accident. In any case, the gathering of risked vehicles can change rapidly because of high speed movement of vehicles.

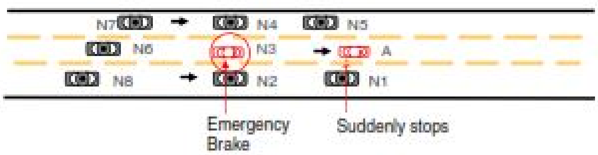

Figure 2.2: Vehicle N3 reacts to the sudden stop of Vehicle A with emergency brake

Take a case, as shown in Figure 2.2 [9], Suppose Vehicle A abruptly breaks down in the middle of the road, its neighboring Vehicles are in possible danger. Vehicles N1, N2, N3, N4 and N5 are in the endangered zone. But very quickly, Vehicles N1 and N5 will cross Vehicle A and therefore the Emergency Warning Message is not necessary for them. However Vehicles N6, N7 and N8 are getting closer to Abnormal Vehicle A and therefore its necessary for them to get the Emergency Warning Message (EWM) and warn them about the road condition ahead.

Challenge 2 : Over a long period of stipulated time, it should sustain numerous abnormal vehicles together

Take a case, if a Vehicle abruptly breaks down due to some reason in the middle of the road, then it stays risky to any vehicle coming near to it or following it till it is evacuated from the road. As it is also possible, the AV can stay in the abnormal way for a long period of time. Moreover, this type of emergency event on the street can have a chain impact. When one vehicle stops due to some reason maybe a mechanical failure, the vehicle following it will apply the brake and subsequently vehicles behind the following vehicle also applies brake. Thus it creates a chain impact.

As we know that, an AV can stay in that state for a long stretch of time and moreover due to chain impact, there is a more likely possibility that there can be numerous co-existing AVs at an instant of time. Consequently in order to support very little delivery delay, we also have to support numerous AVs together at a time. Hence Co-existing AVs can be described as all the AVs whose presence intersect in time interval and whose EWM broadcasts will tangle with each other.

Challenge 3 : To differentiate between warning messages and thus to remove similar EWMs

Take a case, as shown in Figure 2.3 [9], The driver in Vehicle A losses it control over the vehicle and the vehicle is in an abnormal condition. It is moving in different directions and crossing over to other lanes. In the Figure 2.3, Vehicle N1 and Vehicle N3 react to the circumstances, they both apply the brakes and stops on the road. Vehicle N1 and Vehicle N3 both are now abnormal vehicles along with Vehicle A so they all start sending EWM to other vehicles, which are following them. As the direction of Vehicle A is not fixed, it can also move into the lane in which Vehicle N5 is moving after sometime and therefore it might collide with Vehicle N5. Therefore it's necessary for Vehicle A to send it EWM to all the Vehicles nearby either they are moving on the same lane or not.

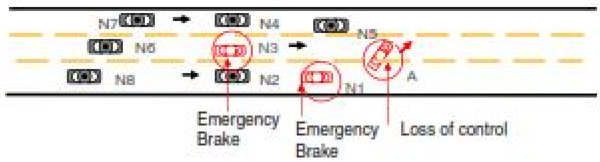

Figure 2.3: Uncontrol Vehicle A moving into different lane.

In reality, the drivers of the different vehicles following Vehicle A can react differently to the situation. Let's take the case of Figure 2.2, here EWM from Vehicle A is useless until Vehicle N3 halts behind it and keep sending the EWM of its own. If after some time, the driver of N3 change the lane and drive away. Then it's necessary for Vehicle A to send out EWM again, if it is still stays ceased amidst the road.

2.3 Related Work

Many research work has already been done on this field, Vehicle-to-Vehicle Communication (V2V). All the research work has been focused on mainly two phases: Medium Access Control, Message Forwarding. A Wireless token ring MAC protocol (WTRP) for vehicle communication was proposed by LEE et.al[9]. In this protocol all the vehicles in formed a group and drove cooperatively. Numerous slot reservation MAC protocol and R-AlOHA for V2V communication was proposed by Lee et.al[1]. Location based broadcast communication protocol was proposed by Xu et. al. In this protocol all vehicles emitted Emergency Warning Message at a steady rate.

With the use of Multi-hop broadcast protocol, messages can be forwarded to help Emergency Warning Message to reach out to the Vehicles which are outside the transmission range of the abnormal vehicle[7]. The above protocol is established with the help of slot reservation MAC.

2.4 Motivation

Accidents occurs because of fast moving vehicles and moreover vehicular accidents are taking away life of millions of people. So Decreasing Emergency Warning Message (EWM) delay is a vital territory of research in VANET .Thereafter accidents and over-crowding of road can be decreased. The chances of occurrence of accidents as a result of fast vehicle is more than that of the normal speeding vehicle. So it takes the life of individuals in a direct or indirect way. As the life of a people is critical, by identifying abnormal vehicles (AV's) by alarming the drivers in the radar of an AV can lessen the no of accidents, and safety can be given to the individuals and to the drivers.

2.5 Objective

- To study the performance of some existing Emergency Message Warning Protocols
- To design and develop an efficient Emergency Message Warning Protocol in VANET.

Chapter 3

Proposed Work

Usually, the sensors inside the vehicles recognize the abnormal behavior of the moving vehicles. A vehicle can turn into an abnormal vehicle (AV) due to some reasons. The reasons can be because of unforeseen road dangers or because of mechanical failure or perhaps due to different AVs close to it, it can also turn into an AV. After some time if it return back to its typical state and resumes its steady movement the vehicle is no more called an AV. However it has been assumed that the vehicle motion is monitored by a vehicle controller and whenever the vehicle shows some abnormal behavior then emergency collision warning protocol starts sending out EWMs. Vehicles which are adjacent to the abnormal vehicle receive the EWM, they can check the pertinence to the emergency occurrence taking into account its relative movement to the AV. Each message utilized as a part of Vehicular collision warning protocol is intended for a group of recipients, and the group of intended receiver's fluctuates very quickly because of high movement of vehicles, which require the message transmissions to be broadcast rather than unicast. To guarantee unfailing conveyance of emergency warning message over problematic wireless channel, EWMs need to be transmitted frequently.

Here, there is no response from the channel as it normally happens in normal congestion control protocol. In normal congestion control protocol to achieve effectiveness, transmission rate is modified as per the channel response. The transmission rate is incremented if the packet passes through successfully and if the packets get lost then the transmission rate is decremented. As it is a broadcast way of sending EWM therefore there is no way to maintain a check on the transmission rate of packet flow.

3.1 Collision Avoidance Model

In this model, as shown in Figure 3.1 [13], we have five vehicles named as Vehicle 1, Vehicle 2, Vehicle 3, Vehicle 4 and Vehicle 5. Here Vehicle 2 is the abnormal vehicle emitting EWM to its neighboring vehicles.

Where,

S_{rel} = *Relative distance between two vehicles.*

ΔV = *Relative speed difference two vehicles.*

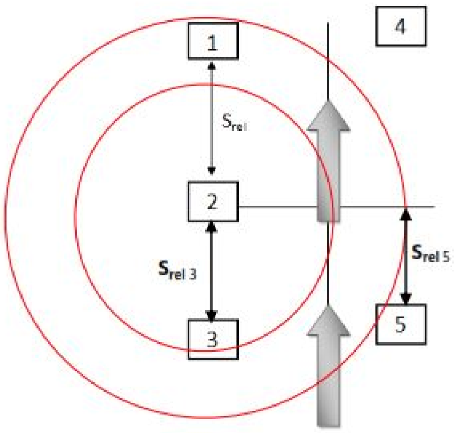

Figure 3.1: Collision Avoidance Model.

Convention of signs used in the model:

- If abnormal vehicle is in front of the other vehicle, then the value of S_{rel} is taken as "Positive"
- If abnormal vehicle is at the back of the other vehicle, then the value of S_{rel} is taken as "Negative"
- If abnormal vehicle has greater speed than other vehicle, then the value of ΔV is "Positive"
- If abnormal vehicle has lesser speed than other vehicle, then the value of ΔV is "Negative"

3.2 Assumption

- Every vehicle has a digital map and a Global Position System (GPS) installed in it so that it can obtain its own geographical location and determine its relative position on the road with respect to an AV, respectively.
- Every vehicle has at least one wireless transceiver on it and each of the vehicle compose the vehicular ad hoc networks.
- 300 meters is assumed to be the transmission range of the vehicles and by using IEEE 802.11 DCF based multi-access control protocol the channel contention is fixed.

3.3 Proposed algorithm

In Figure 3.2 [13], Flow diagram of the algorithm is shown. The messages that a Vehicle gets from other vehicle will be arranged according to its priority in the priority queue and hence the messages will be executed one after one as it has been arranged in priority queue of the vehicle control system. Once the vehicle gets a message from an abnormal vehicle, it will calculate the relative distance (S_{rel}) between its position and the abnormal vehicle. If it is found to be Negative as per the sign convention then it will discard the message as other vehicle is in front of the abnormal Vehicle and will not be in danger because of abnormal vehicle or else it will again check for their relative speed (ΔV) between them. If it is found to be Negative then the driver of the other vehicle will apply the brake slowly so that it will stop in time by the time it get close to the abnormal vehicle or else it will check if its distance from the abnormal vehicle is a safe or not. If it is very close to the abnormal vehicle i.e its distance is less than the safe distance from the abnormal vehicle then the driver of the other vehicle will apply brake hard so that vehicle can stop in time or else it will collide with the abnormal vehicle on the road. Moreover whenever a vehicle applies a brake then it will start sending EWM automatically.

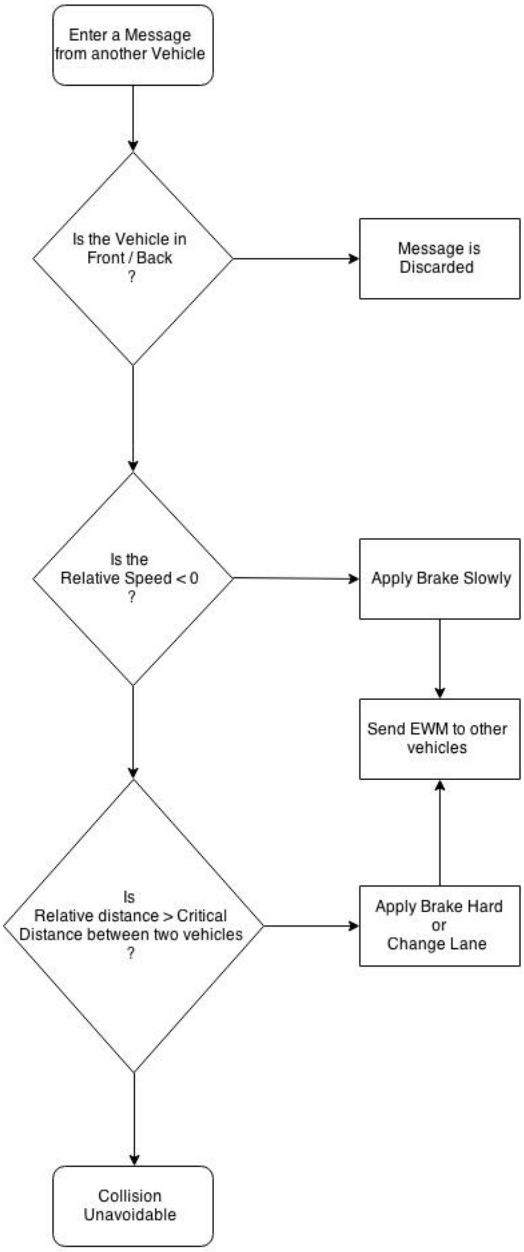

Figure 3.2: Flow Diagram of the Proposed algorithm.

As discussed earlier, each message has a priority and the messages are arranged in the vehicle queue as per their priority. When a message enters the vehicle its priority is estimated according to a function, it's requires two parameters: one is Relative speed between the two vehicles and the second one is the relative distance between the vehicles along with its sign.

Priority function: PRI = - (S_{rel} * ΔV)

Whenever a new message packet enter into the vehicle message queue, it calculates the priority by using the above function, if there is no message in the vehicle message queue then the first message that enters becomes the first node in the queue of the vehicle message queue. Afterwards when more messages enter into the vehicle and they get sorted according to their priority. After a stipulated time interval, the messages get executed one after one as per their sequence number in the queue. The design of the node is shown in Figure 3.3 [13].

PRI - Priority of the message is stored here

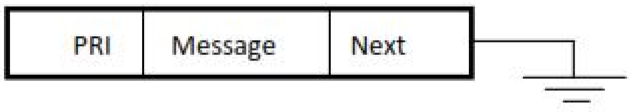

Figure 3.3: Design of the node.

As we know that a vehicle can turn into an abnormal vehicle due to the presence of other abnormal vehicle nearby.Hence it will also start emitting the same EWM to other vehicles adjacent to it. It is estimated that on a dense traffic road, we will have around 20-25 vehicles emitting the same EWM at the same time within a minute. When a large number of vehicles emit the same EWM it will obviously consume lot of bandwidth of the channel. Which will make the bandwidth congested and hence it will delay the delivery of EWM to the approaching vehicles, which would obviously prove to be fatal for the driver of the vehicle. So the main objective of the next algorithm is to ensure that all the vehicles in the danger zone of the abnormal vehicle get the EWM within lesser time and this can be achieved by eliminating the unnecessary repetitive EWM from the channel.

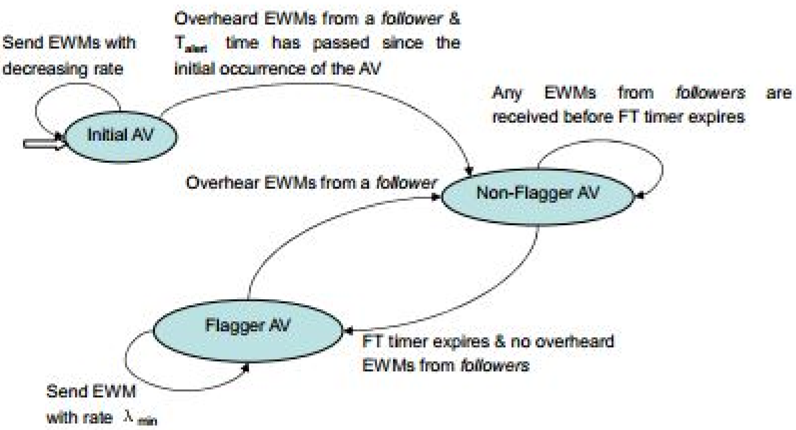

Figure 3.4: Transition state model.

According to this algorithm, as shown in Figure 3.4 [9], a vehicle can be in one of these three states: Initial AV state, Non-Flagger AV, Flagger AV. When a vehicle abruptly applies the brakes due to unfavorable road condition,mechanical failure or due to other AV nearby then it turns into an AV and it enters into Initial AV state.

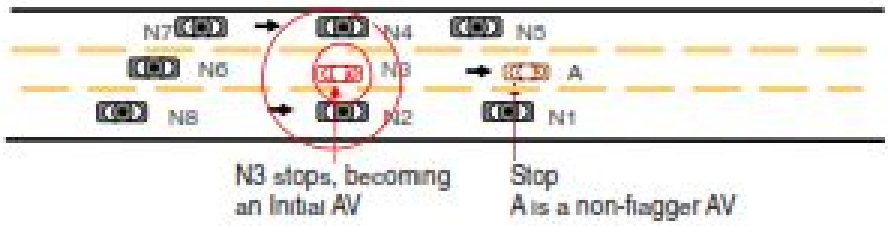

Figure 3.5: Vehicle N3 Becomes an Initial AV and Vehicle A becomes Non-Flagger AV.

A vehicle turns from an Initial AV state to Non-Flagger AV state, if the abnormal vehicle overhears the same EWMs from one of the vehicle following it. Thus stopping to generate EWMs for some time and starts a timer called flagger Timeout duration. As shown in the Figure 3.5 [9], Vehicle N3 enters into Initial AV state because the driver in Vehicle N3 applies brake after getting the EWM from Vehicle A. When Vehicle A hears that the same EWM is being transmitted from a Vehicle behind it, it stops transmitting EWMs and enters into Non-Flagger AV state.

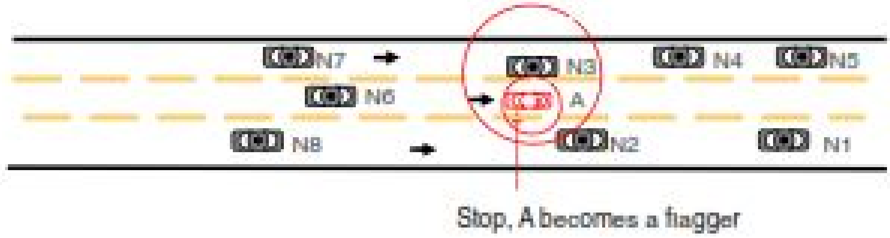

Figure 3.6: Vehicle N3 drives away and Vehile A becomes Flagger AV.

When the flagger Timeout timer expires and the abnormal vehicle cannot hear the EWM from the vehicle following it then it turn from a Non-Flagger AV state to Flagger AV state. As shown in Figure 3.6 [9], After sometime, the driver in Vehicle N3 finds a gap on the adjacent lane so he changes the lane and drives away. When the flagger Timeout timer expires and the abnormal vehicle A cannot hear the EWM from the vehicle N3, it enters into Flagger AV state. Thereafter it again start transmitting the EWMs to other vehicles close to it.

Chapter 4

Simulation & Results

In this chapter Simulation and their respective result are shown to prove that the algorithm proposed in the previous chapter is efficient to accomplish the required objective. Simulation has been done using NS-2.34 (Network Simulator) and SUMO-0.23.0 (Traffic Simulators). NS-2 and Sumo was integrated to generate a real world traffic movement and analysis of the packet movement was done by the use of Tracegraph, a graph plotting software was used to plot throughput of the packets flow.

4.1 Simulation Environment

First of all, a traffic movement was created and was simulated using SUMO-0.23.0, There are two types of vehicle moving in Figure 4.1, one is Car and other one is Truck with their respective max speed, acceleration and deacceleration rate. The Roads in Figure 4.1 are one way road having two lane.

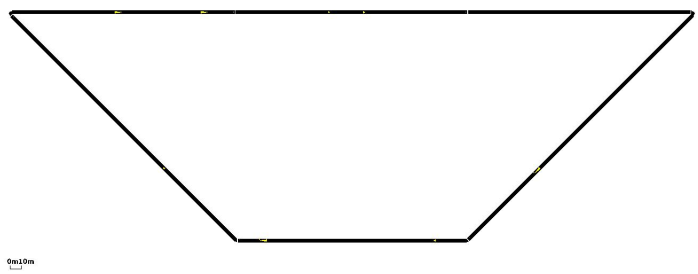

Figure 4.1: Simulation in Sumo.

Then the movement of the vehicle as nodes were simulated in NS-2.34 under the following scenario

Number of Nodes	8
Simulation area	500 * 500
Routing Protocol	AODV
Packet Type	CBR
Packet Size	512 bytes
Simulation Time	100

Table 4.1: Configuration for Simulation in NS-2.

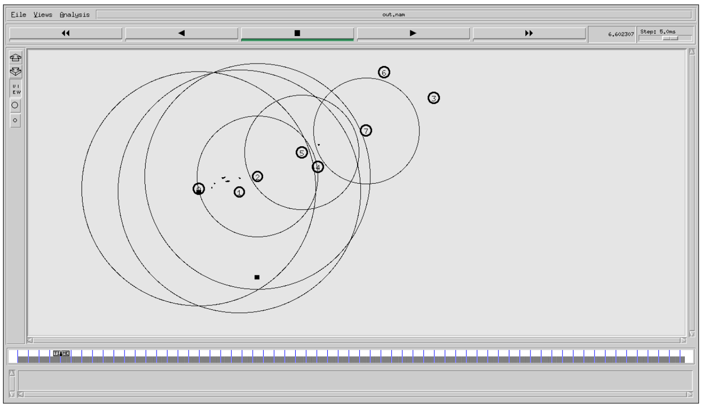

Figure 4.2: Simulation in NS-2.

Then the trace files from NS-2.34 was analysed using Tracegraph

4.2 Simulation Result

Simulation statistics and throughput of the packets generated, Received at different nodes, Dropped at various nodes has been shown with the help of graph in the Figure 4.3, Figure 4.4, Figure 4.5 and Figure 4.6 respectively.

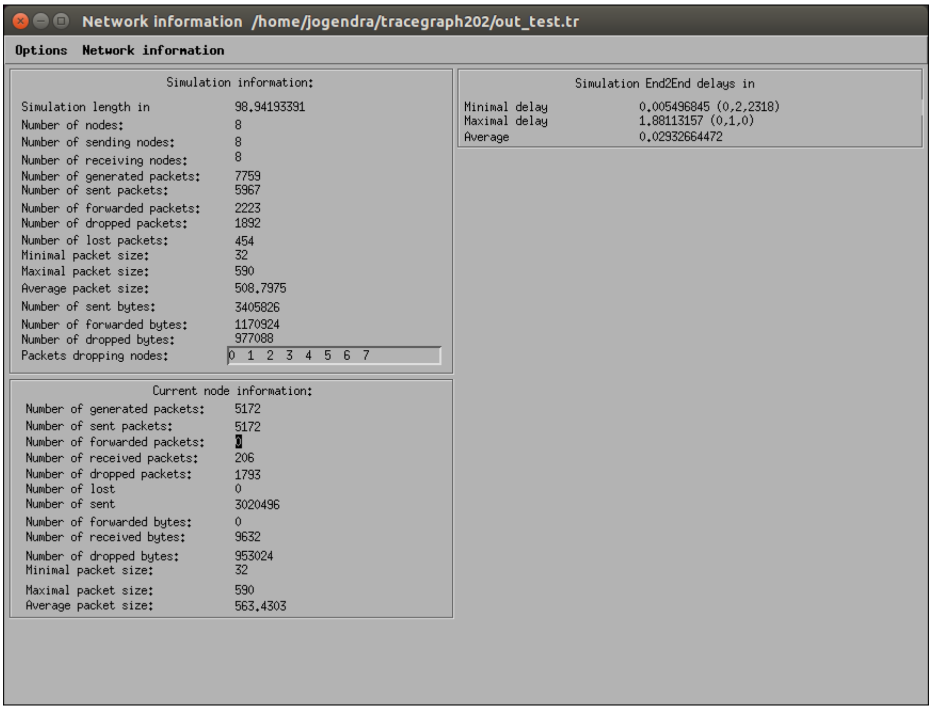

Figure 4.3: Simulation Statistics.

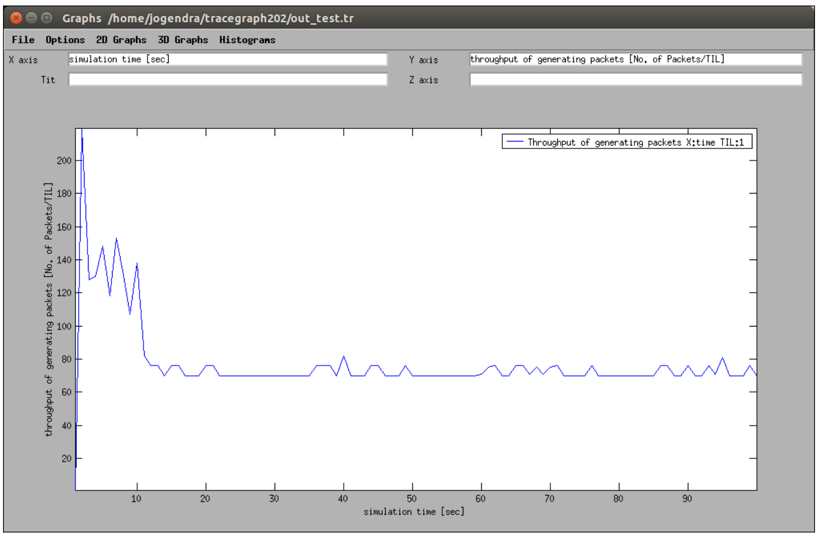

Figure 4.4: Throughput of Packets Generated.

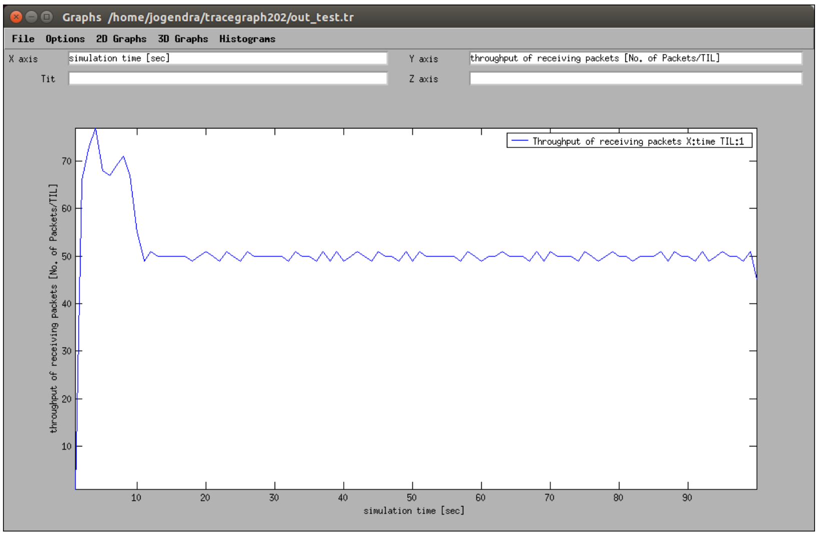

Figure 4.5: Throughput of Packets Received.

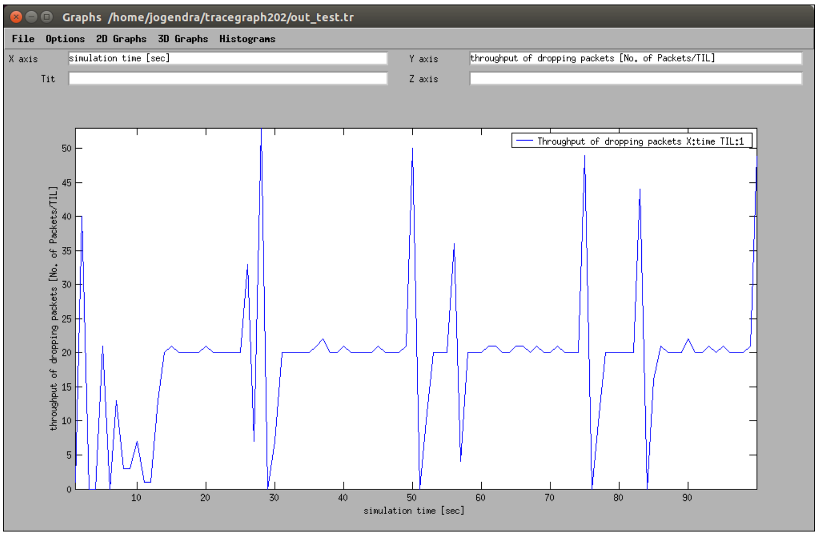

Figure 4.6: Throughput of Packets Dropped.

Chapter 5

Conclusions and Future Work

The proposed algorithm in this thesis shows how collision could be avoided, hence enhancing the safety in the road. This algorithm also helps in reducing the repetitive EWMs emitted from the vehicles, which are unnecessary so as to reduce the consumption of bandwidth. Thereafter reducing the delivery delay of Emergency Warning Message so that all vehicles in the danger zone i.e in the transmission range of the abnormal vehicle can get the EWMs in time and can take appropriate action as per the algorithm discussed in the previous chapters. Moreover reducing the repetitive EWMs is beneficial in a dense road, where a large number of vehicles can be supported in the Vehicular Ad-Hoc Network established at that instant of time.

There are a number of other things that can be done in this field. one of them is improvement in GPRS accuracy, as GPRS gathers information and updates at a rate of 1 Hz. This rate is very slow in a term of VANET as the vehicles are moving at a very high speed. The latency in updation will delay the time in vehicle control system for the calculation of exact distance between two vehicles. After all as we know little delay can prove to be very fatal for the driver of the vehicles.

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